FORM PTO-1390 (REV. 11-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 450118-02400
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known see 37 C.F.R. 1.5) 09/936337
INTERNATIONAL APPLICATION NO. PCT/JP00/01483	INTERNATIONAL FILING DATE 10 MARCH 2000	PRIORITY DATE CLAIMED 12 MARCH 1999

TITLE OF INVENTION **TRANSMITTING APPARATUS AND METHOD AND PROVISION MEDIUM**

APPLICANT(S) FOR DO/EO/US **Yasunari IKEDA, Tamotsu IKEDA, Takahiro OKADA**

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 – 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

    PCT/RO/101 PCT/ISA/210
    PCT/IB/301, 304, 308, 332, 338, PCT/IPEA/409
    9 Sheets of Drawings, 1 Page Abstract

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Date of Deposit: **September ~~11~~, 2001**

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U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NO.
09/936537	PCT/JP00/01483	450118-02400

21. ☒ The following fees are submitted	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO $1000.00		
International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $860.00		
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International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4 ..... $690.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total Claims	2 - 20 =	0	x $18.00	$ 0.00	
Independent Claims	2 - 3 =	6	x $80.00	$ 480.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $270.00	$	
TOTAL OF ABOVE CALCULATIONS =				$	
☐ Applicant claims small entity status. See 37 C.F.R. 1.27. The fees indicated above are reduced by ½.			+	$	
SUBTOTAL =				$ 1,340.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$ 0.00	
Fee for recording the enclosed assignments (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property			+	$ 0.00	
TOTAL FEES ENCLOSED =				$ 1,340.00	
				Amount to be refunded:	$
				Charged:	$

a. ☒ One check in the amount of **$ 1,340.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **50-0320**. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. WARNING: Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

WILLIAM S. FROMMER, ESQ.
FROMMER LAWRENCE & HAUG LLP
745 FIFTH AVENUE
NEW YORK, NEW YORK 10151

Dated: September 12, 2001

William Frommer
SIGNATURE

WILLIAM S. FROMMER
NAME

25,506
REGISTRATION NUMBER

LIST OF REFERENCES

1... transmitter

2... OFDM modulation circuit

3... frequency conversion circuit

4, 5... PLL circuit

21... phase comparison unit

22... frequency division circuit

23... LPF

24... voltage controlled oscillator

41... OFDM demodulation circuit

450118-02400

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: IKEDA, et al.

Filed.: Filed Concurrently Herewith

Title of Invention: TRANSMITTING APPARATUS AND METHOD AND PROVISION MEDIUM

745 Fifth Avenue
New York, NY 10151

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Date of Deposit: September 12, 2001

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Edward Nay
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PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
BOX PCT
Washington, D.C. 20231

Sir:

Before the issuance of the first Office Action, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Please replace the paragraph beginning at page 11, line 5, with the following rewritten paragraph:

--The guard interval insertion unit 14 inserts a guard interval to the input signal. In the OFDM modulation scheme, as shown in FIG. 3, a transmission signal is generated by combining carriers 1 through k as modulated waves modulated by using for example 64 QAM (quadrature amplitude modulation). The transmission symbol duration is comprised by the guard interval and an effective symbol duration. The guard interval is the signal duration provided for reducing the influence of multipath interference (ghost) and is obtained by cycling and repeating part of a signal waveform of the effective symbol duration.--

IN THE CLAIMS:

Please cancel claim 1-9 and add claims 10-18 as follows:

--10. A transmitting apparatus for OFDM (orthogonal frequency division multiplexing) modulating and transmitting predetermined information, said transmitting apparatus characterized by including

a first generating means for inputting a first window signal serving as a reference and for generating a clock signal and a second window signal in accordance with the first window signal,

a modulating means for modulating an OFDM signal in accordance with the information by using the clock signal and the second window signal,

a second generating means for generating a predetermined RF (radio frequency) signal in accordance with the second window signal, and

a frequency conversion means for converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channel becomes a whole multiple of the interval between carriers adjacent to each other within a channel.

11. A transmission method for OFDM modulating and transmitting predetermined information, said transmission method characterized by including

an input step of inputting a first window signal serving as a reference,

a first generation step of generating a clock signal and a second window signal in accordance with the first window signal input at the input step,

a modulation step of modulating an OFDM signal in accordance with the information by using the clock signal and the second window signal,

a second generation step of generating a predetermined RF (radio frequency) signal in accordance with the second window signal, and

a frequency conversion step of converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channel becomes a whole multiple of the interval between carriers adjacent to each other within a channel.

12. A provision medium characterized in that it provides, to a transmitting apparatus for OFDM modulating and transmitting predetermined information, a computer readable program for making it run processing including

an input step of inputting a first window signal serving as a reference,

a first generation step of generating a clock signal and a second window signal in accordance with the first window signal input at the input step,

a modulation step of modulating an OFDM signal in accordance with the information by using the clock signal and the second window signal,

a second generation step of generating a predetermined RF (radio frequency) signal in accordance with the second window signal, and

a frequency conversion step of converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channel becomes a whole multiple of the interval between adjacent carriers within a channel.

13. A transmitting apparatus for OFDM modulating and transmitting predetermined information, said transmitting apparatus characterized by including

a first generating means for demodulating an OFDM signal serving as a reference and for generating a window signal and a clock signal,

a modulating means for modulating an OFDM signal in accordance with the information by using the window signal and the clock signal generated by the first generating means,

a second generating means for generating a predetermined RF (radio frequency) signal in accordance with the window signal, and

a frequency conversion means for converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channels becomes a whole multiple of the interval between carriers adjacent to each other within a channel.

14. A transmission method for OFDM modulating and transmitting predetermined information, said transmission method characterized by including

an input step of inputting an OFDM signal serving as a reference,

a first generation step of demodulating the OFDM signal input in the input step and generating a window signal and a clock signal,

a modulation step of modulating an OFDM signal in accordance with the information by using the window signal and the clock signal,

a second generation step of generating a predetermined RF (radio frequency) signal in accordance with the window signal, and

a frequency conversion step of converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channels becomes a whole multiple of the interval between carriers adjacent to each other within a channel.

15. A provision medium characterized in that it provides, to a transmitting apparatus for OFDM modulating and transmitting predetermined information, a computer readable program for making it run processing including

an input step of inputting an OFDM signal serving as a reference,

a first generation step of demodulating the OFDM signal input in the input step and generating a window signal and a clock signal,

a modulation step of modulating an OFDM signal in accordance with the information by using the window signal and the clock signal,

a second generation step of generating a predetermined RF (radio frequency) signal in accordance with the window signal, and

a frequency conversion step of converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channels becomes a whole multiple of the interval between carriers adjacent to each other within a channel.

16. A transmitting apparatus for OFDM modulating and transmitting predetermined information, said transmitting apparatus characterized by including

a modulating means for inputting a window signal and a clock signal serving as a reference and modulating an OFDM signal in accordance with the information by using the window signal and the clock signal,

a generating means for generating a predetermined RF (radio frequency) signal in accordance with the window signal, and

a frequency conversion means for converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channels becomes a whole multiple of the interval between carriers adjacent to each other within a channel.

17. A transmission method for OFDM modulating and transmitting predetermined information, said transmission method characterized by including

an input step of inputting a window signal and a clock signal serving as a reference,

a modulation step of modulating an OFDM signal in accordance with the information by using the window signal and the clock signal input at the input step, and

a generation step of generating a predetermined RF (radio frequency) signal in accordance with the window signal, and

a frequency conversion step of converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channels becomes a whole multiple of the interval between carriers adjacent to each other within a channel.

18. A provision medium characterized in that it provides, to a transmitting apparatus for OFDM modulating and transmitting predetermined information, a computer readable program for making it run processing including

an input step of inputting a window signal and a clock signal serving as a reference,

a modulation step of modulating an OFDM signal in accordance with the information by using the window signal and the clock signal input at the input step,

a generation step of generating a predetermined RF (radio frequency) signal in accordance with the window signal, and

a frequency conversion step of converting frequencies of the OFDM signal based on the RF signal so that a carrier interval between adjacent channels becomes a whole multiple of the interval between carriers adjacent to each other within a channel.--

REMARKS

The specification has been amended. Changes to the specification are indicated in the attached paper entitled "**Version with Markings to Show Changes Made.**" Claims 1-9 have been cancelled. Claims 10-18 have been added to the application. All of these amendments reflect the amendments to the International Application made under PCT Article 34. The filing fee has been calculated based upon these new claims.

In the accompanying Request for Approval of Drawing Changes, Figure 8 has been amended to add "OFDM SIGNAL" to block 4.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP
Attorneys for Applicant

By: 

William S. Frommer
Reg. No. 25,506
Tel. (212) 588-0800

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

Paragraph beginning at line 5 of page 11 has been amended as follows:

The guard interval insertion unit 14 inserts a guard interval to the input signal. In the OFDM modulation scheme, as shown in FIG. 3, a transmission signal is generated by combining carriers 1 through k as modulated waves modulated by using for example 64 QAM (quadrature amplitude modulation). The transmission symbol duration is comprised by the guard interval and an effective symbol duration. The guard interval [of k] is the signal duration provided for reducing the influence of multipath interference (ghost) and is obtained by cycling and repeating part of a signal waveform of the effective symbol duration.

PATENT
450118-02400

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Ikeda, et al.
Int'l Appln. No.	:	PCT/JP00/01483
Int'l Filing Date	:	March 10, 2000
For	:	TRANSMITTING APPARATUS AND METHOD AND PROVISION MEDIUM

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Edward Nay
(Typed or printed name of person mailing paper or fee)

(Signature of person mailing paper or fee)

REQUEST FOR APPROVAL OF DRAWING CHANGES

Sir:

Approval of the following drawing change, which is indicated in red ink on the enclosed photocopy, is respectfully requested:

In Fig. 8, please add the following legends to the noted block:

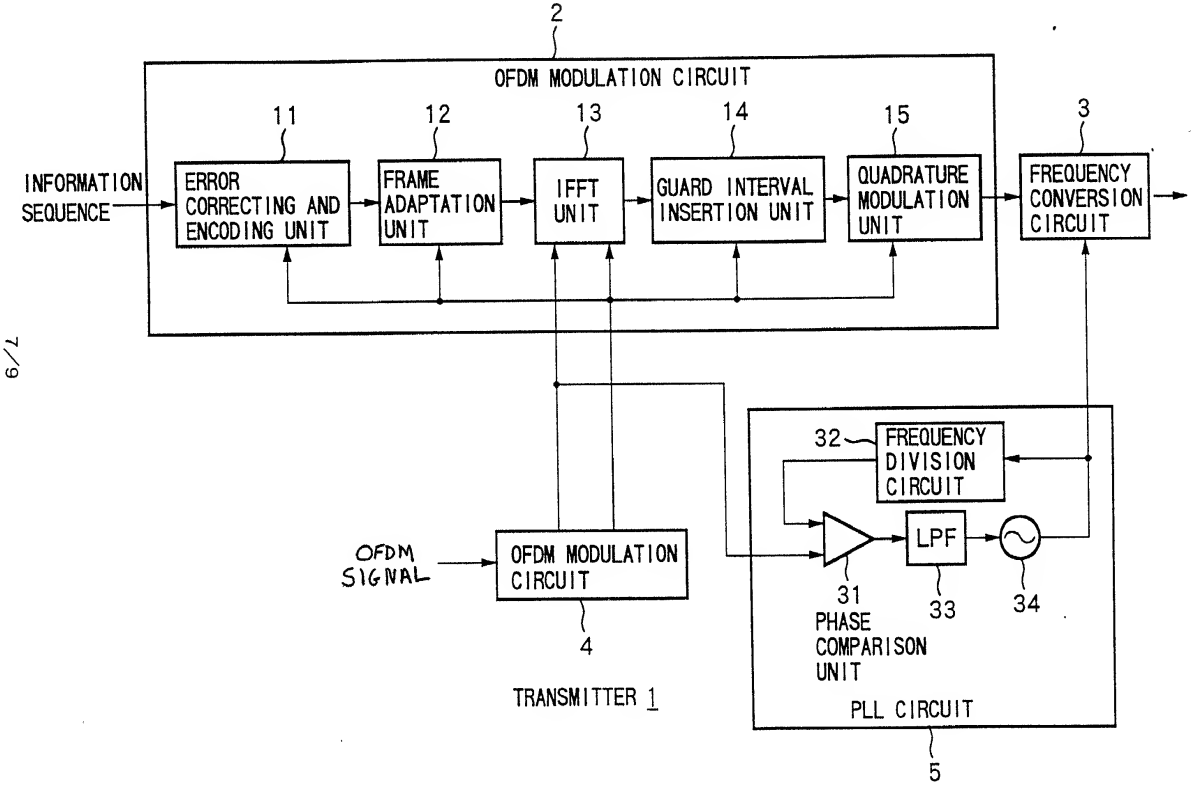
Fig. 8, --OFDM SIGNAL -- is added as the input to block 4.

Formal drawings incorporating these changes will be submitted following receipt of the Notice of Allowance.

Respectfully submitted,
FROMMER LAWRENCE & HAUG LLP

By: ______________________
William S. Frommer
Reg. No. 25,506
(212) 588-0800

FIG.8



DESCRIPTION

TRANSMITTING APPARATUS AND METHOD AND PROVISION MEDIUM

TECHNICAL FIELD

The present invention relates to a transmitting apparatus and method and a provision medium for the same, more particularly relates to a transmitting apparatus and method for transmitting a signal which can correctly detect a desired signal even without providing a guard band usually provided for preventing interference from an adjacent signal and a provision medium for the same.

BACKGROUND ART

The OFDM (orthogonal frequency division multiplexing) transmission system has tolerance against multipath interference, so is known as a transmission system suitable for digital transmission using terrestrial waves. The OFDM transmission system is being employed as a provisional system by the Japanese Telecommunications Technology Council for its digital terrestrial television broadcast system (hereinafter referred to as the "wideband ISDB-T" system) and digital terrestrial radio system (hereinafter referred to as the "narrowband ISDB-T system").

At the start of digital broadcasts, it can be considered that there will be a duration of coexistence with the analog broadcasts already in service. Also, it is proposed to abolish analog broadcasts after the shift to digital broadcasts has sufficiently advanced. For the duration of coexistence of analog broadcasts and digital broadcasts, it is necessary to give sufficient consideration so that the digital broadcasts do not interfere with the already existing analog broadcasts. In the wideband ISDB-T system comprised by 13 segments, as shown in FIG. 1, one segment's bandwidth (about 429 kHz) is provided as a guard band to separate upper and lower adjacent channels (so that there is no interference from an adjacent channel).

FIG. 1 shows a case where such consideration is given by providing a guard band between each two adjacent channels among a channel 1 (ch1) having a center frequency f_1, ch2 having a center frequency f_2, and ch3 having a center frequency f_3.

However, the provision of guard bands as mentioned above means a reduction of the efficiency of use of the frequency, so is not preferred from the viewpoint of effective utilization of the frequency. Also, when the analog broadcasts are abolished and digital broadcasts are shifted to, it is desired that there be no

interference between adjacent digital signals even if no guard bands are provided.

DISCLOSURE OF THE INVENTION

The present invention was made in consideration with such a circumstance and has as an object thereof to enable a desired signal to be obtained without receiving interference from an adjacent signal even without providing a guard band.

A transmitting apparatus disclosed in claim 1 is characterized by including an inputting means for inputting a first window signal serving as a reference, a first generating means for generating a first clock and a second window signal from the first window signal input by the inputting means, a modulating means for modulating an OFDM signal in accordance with the information by using the first clock and the second window signal, and a second generating means for generating, from the second window signal, a second clock for controlling a transmission interval of OFDM signals so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

A transmission method disclosed in claim 2 is characterized by including an input step of inputting a first window signal serving as a reference, a first

generation step of generating a first clock and a second window signal from the first window signal input at the input step, a modulation step of modulating an OFDM signal in accordance with information by using the first clock and the second window signal, and a second generation step of generating, from the second window signal, a second clock for controlling a transmission interval of OFDM signals so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

A provision medium disclosed in claim 3 is characterized in that it provides, to a transmitting apparatus, a computer readable program for making it run processing including an input step of inputting a first window signal serving as a reference, a first generation step of generating a first clock and a second window signal from the first window signal input at the input step, a modulation step of modulating an OFDM signal in accordance with information by using the first clock and the second window signal, and a second generation step of generating, from the second window signal, a second clock for controlling a transmission interval of OFDM signals so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the

interval of carriers adjacent to each other in the OFDM signal.

A transmitting apparatus disclosed in claim 4 is characterized by including an inputting means for inputting an OFDM signal serving as the reference, a first generating means for generating a window signal and a first clock by demodulating the OFDM signal input by the inputting means, a modulating means for modulating an OFDM signal in accordance with information by using the window signal and first clock generated by the first generating means, and a second generating means for generating, from the window signal generated by the first generating means, a second clock for controlling a transmission interval of OFDM signals generated by the modulating means so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

A transmission method disclosed in claim 5 is characterized by including an input step of inputting an OFDM signal serving as a reference, a first generation step of generating a window signal and a first clock by demodulating the OFDM signal input at the input step, a modulation step of modulating an OFDM signal in accordance with information by using the window signal

and first clock generated at the first generation step, and a second generation step of generating, from the window signal generated at the first generation step, a second clock for controlling a transmission interval of OFDM signals generated at the modulation step so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

A provision medium disclosed in claim 6 is characterized in that it provides, to a transmitting apparatus, a computer readable program for making it run processing including an input step of inputting an OFDM signal serving as a reference, a first generation step of generating a window signal and a first clock by demodulating the OFDM signal input at the input step, a modulation step of modulating an OFDM signal in accordance with information by using the window signal and first clock generated at the first generation step, and a second generation step of generating, from the window signal generated at the first generation step, a second clock for controlling a transmission interval of OFDM signals generated at the modulation step so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

A transmitting apparatus disclosed in claim 7 is characterized by including an inputting means for inputting a window signal and a first clock serving as a reference, a modulating means for modulating an OFDM signal in accordance with information by using the window signal and first clock input by the inputting means, and a generating means for generating, from the window signal input by the inputting means, a second clock for controlling a transmission interval of OFDM signals generated by the modulating means so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

A transmission method disclosed in claim 8 is characterized by including an input step of inputting a window signal and first clock serving as a reference, a modulation step of modulating an OFDM signal in accordance with information by using the window signal and first clock input at the input step, and a generation step of generating, from the window signal input at the input step, a second clock for controlling a transmission interval of OFDM signals generated by the modulating means so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the

OFDM signal.

A provision medium disclosed in claim 9 is characterized in that it provides, to a transmitting apparatus, a computer readable program for making it run processing including an input step of inputting a window signal and first clock serving as a reference, a modulation step of modulating an OFDM signal in accordance with information by using the window signal and first clock input at the input step, and a generation step of generating, from the window signal input at the input step, a second clock for controlling a transmission interval of OFDM signals generated by the modulating means so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

In the transmitting apparatus disclosed in claim 1, transmission method disclosed in claim 2, and the provision medium disclosed in claim 3, the first clock and the second window signal are generated from the input first window signal, an OFDM signal is modulated in accordance with information by using the first clock and the second window signal, and the second clock for controlling the transmission interval of OFDM signals so that the carrier interval between one OFDM signal and an

adjacent OFDM signal becomes a whole multiple of the interval of the carriers adjacent to each other in the OFDM signal is generated from the second window signal.

In the transmitting apparatus disclosed in claim 4, transmission method disclosed in claim 5, and the provision medium disclosed in claim 6, the window signal and the first clock are generated by demodulating the input OFDM signal, an OFDM signal is modulated in accordance with information by using the generated window signal and first clock, and the second clock for controlling the transmission interval of OFDM signals so that the carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of the carriers adjacent to each other in the OFDM signal is generated from the generated window signal.

In the transmitting apparatus disclosed in claim 7, transmission method disclosed in claim 8, and the provision medium disclosed in claim 9, an OFDM signal is modulated in accordance with information by using the input window signal and first clock, and a second clock for controlling the transmission interval of OFDM signals so that the carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of the carriers adjacent to each other in the

OFDM signal is generated from the input window signal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view explaining a guard band.

FIG. 2 is a block diagram of the configuration of an embodiment of a transmitter to which the present invention is applied.

FIG. 3 is a view explaining a guard interval.

FIGS. 4A to 4D are views explaining a window phase.

FIGS. 5A to 5D are views explaining a window phase.

FIGS. 6A and 6B are views explaining a filter.

FIG. 7 is a view explaining conditions 1 through 4.

FIG. 8 is a block diagram of another configuration of the transmitter 1.

FIG. 9 is a block diagram of still another configuration of the transmitter 1.

BEST MODE FOR WORKING THE INVENTION

FIG. 2 is a block diagram of an embodiment of a transmitter to which the present invention is applied. A series of information input to an OFDM modulation circuit 2 of a transmitter 1 is corrected for error and encoded by an error correcting and encoding unit 11 and output to a frame adaptation unit 12. The frame adaptation unit 12 builds frames each comprised of synchronization use symbols, service identification use symbols, and information transmission use symbols. The signal formed

into frames is input to an IFFT (inverse fast Fourier transform) unit 13 where it is subjected to an inverse Fourier transform (OFDM modulated) and then output to a guard interval insertion unit 14.

The guard interval insertion unit 14 inserts a guard interval to the input signal. In the OFDM modulation scheme, as shown in FIG. 3, a transmission signal is generated by combining carriers 1 through k as modulated waves modulated by using for example 64 QAM (quadrature amplitude modulation). The transmission symbol duration is comprised by the guard interval and an effective symbol duration. The guard interval of k is the signal duration provided for reducing the influence of multi-path interference (ghost) and is obtained by cycling and repeating part of a signal waveform of the effective symbol duration.

The signal inserted with the guard interval by the guard interval insertion unit 14 is input to an quadrature modulation unit 15 where it is orthogonally modulated and then output to a frequency conversion circuit 3. The frequency conversion circuit 3 converts the input signal to the frequency for transmission and transmits the same from a not illustrated antenna.

A PLL (phase locked loop) circuit 4 generates a window signal and clock. A phase comparison unit 21

receives as input a window signal serving as a reference and a window signal output from a frequency division circuit 22. The phase comparison unit 21 compares the phases of the two input window signals and outputs the result to an LPF (low pass filter) 23. The LPF 23 extracts a low frequency component of the input signal and outputs the same to a voltage controlled oscillator 24. The voltage controlled oscillator 24 generates a clock for controlling the OFDM modulation circuit 2 from the input signal and provides the same to the units of the OFDM modulation circuit 2.

The clock output from the voltage controlled oscillator 24 is also supplied to the frequency division circuit 22 where it is divided in frequency. The frequency division ratio of the frequency division circuit 22 is set according to the carrier interval of the OFDM signal, that is, the number of points of IFFT and the guard interval length. The clock divided in frequency by the frequency division circuit 22 is supplied as a window signal to the IFFT unit 13 and, at the same time, fed back to the phase comparison unit 21. In this way, the PLL circuit 4 generates a clock and window signal synchronous to the window signal serving as a reference.

The window signal generated by the PLL circuit 4 is

also input to a phase comparison unit 31 of a PLL circuit 5. The PLL circuit 5 compares the phases of the window signal output from a frequency division circuit 32 and the input window signal from the PLL circuit 4 by the phase comparison unit 31 in the same way as the PLL circuit 4, extracts the low frequency component from the result by an LPF 33, and generates a clock by a voltage controlled oscillator 34. The clock generated by the PLL circuit 5 is supplied to the frequency conversion circuit 3.

The transmitter 1 mentioned above satisfies the following four conditions for adjacent OFDM signals (between channels).

[Condition 1] The carrier intervals are equal (effective symbol duration are equal).

[Condition 2] The symbol lengths (guard interval lengths) are equal.

[Condition 3] The IFFT window phases are equal.

[Condition 4] The interval between the carrier at an end portion of the OFDM signal and the carrier of the adjacent OFDM signal nearest that is a whole multiple of the carrier interval in each OFDM signal.

By satisfying all of these four conditions, since at least adjacent OFDM signals satisfy the orthogonal condition, it becomes possible on a receiver side to

eliminate any influence from a signal adjacent to the desired signal and obtain only the desired signal even if no guard interval is provided. Below, the reason for that will be explained.

An explanation will be made of an output of a FFT (fast Fourier transform) at the time of OFDM demodulation by a correct window phase at the receiver side by referring to FIGS. 4A to 4D. First, on the transmission side, an IFFT operation (OFDM modulation) is applied to the signal as shown in FIG. 4A, and OFDM symbols #1, #2, ... as shown in FIG. 4B are generated and transmitted to the receiver side. The carriers in symbols of the OFDM symbols obtained by the IFFT operation are orthogonal to each other. For this reason, no interference of the carriers in the OFDM symbols occurs.

The receiver side applies an FFT operation (OFDM demodulation) to the transmitted OFDM symbols as shown in FIG. 4B by using the FFT window phase (window coincident with the effective symbol duration) having an adequate phase as shown in FIG. 4C and obtains a signal similar to the transmitted signal (FIG. 4A) as shown in FIG. 4D. In this way, when demodulating by the correct FFT window phase, carriers are orthogonal, so the phases and frequencies of the carriers are correctly detected.

However, as shown in FIGS. 5A to 5D, if demodulating

using an FFT window phase having an incorrect phase, the carriers are mixed with each other, so the correct signal cannot be detected. Namely, where the FFT window phase crosses over two OFDM symbols as shown in FIG. 5C, the carrier component of each symbol will flow into the carrier component of the other symbol, in other words, the orthogonal condition is no longer satisfied, so an erroneous signal different from the transmitted signal (FIG. 5A) is detected as shown in FIG. 5D.

Due to the above, the FFT window phases must be equal. Therefore, at the transmission side, the condition 3 that the IFFT window phases be equal is derived. However, even if the window phases are equal, if the transmission symbol duration have different lengths depending on the symbols, the signal of an adjacent symbol will flow into the signal of the desired symbol. Accordingly, it is necessary to make the transmission symbol duration equal. Therefore, the condition 1 that the intervals between effective symbols be equal and the condition 2 that the guard interval lengths be equal are derived.

When adjacent OFDM signals are transmitted while arranged close, the reception side uses a sharp filter to remove the signals adjacent to the desired signal. However, the adjacent signals leak in due to the filter,

so the correct signal cannot be obtained. Namely, the signal obtained by filtering the reception signal as shown in FIG. 6A, extracting the desired signal, and applying an FFT to that extracted signal is affected by the adjacent signal as shown in FIG. 6B, so is not correctly demodulated.

The demodulated signal is affected by the signal failed to be eliminated by the filter leaking into the desired signal in this way when the leaked signal and the desired signal are not orthogonal. There is no influence exerted upon the desired signal when the leaked signal and the desired signal are orthogonal. Accordingly, if the adjacent signal and the desired signal are made orthogonal, it becomes possible to correctly detect the desired signal free from the influence of the adjacent signal. As the condition for the adjacent signal and desired signal being orthogonal, the condition 4 that the carrier interval of the nearest carriers become a whole multiple of each OFDM signal carrier interval is derived.

As shown in FIG. 7, in an N-channel OFDM signal and an adjacent N+1 channel OFDM signal, by satisfying all of the condition 1 that the effective symbol lengths thereof be equal, the condition 2 that the guard lengths be equal, the condition 3 that the IFFT window phases be equal, and the condition 4 that the carrier interval

between channels become a whole multiple of the carrier interval in a channel, it becomes possible to detect the signal of the desired channel free from influence from the signals of the adjacent channel even if no guard band is provided between the channel N and the channel N+1.

In the transmitter 1 shown in FIG. 2, the PLL circuit 4 operates so as to satisfy the conditions 1 through 3, and the PLL circuit 5 operates so as to satisfy the condition 4. Namely, by generating the window signal and clock of IFFT to be used by the IFFT unit 13 synchronous to the reference window signal input to the phase comparison unit 21 of the PLL circuit 4, the conditions 1 through 3 are satisfied. Further, the IFFT window signal (corresponding to the interval of carriers in the OFDM signal) to be supplied to the IFFT operation unit 13 is supplied as a reference signal to the PLL circuit 5 for generating the carrier (RF signal) to be supplied to the frequency conversion circuit 3, so it becomes possible to generate the OFDM signal of the RF signal band while correctly keeping the OFDM carrier interval with the adjacent channel, that is, satisfy the condition 4.

FIG. 8 is a block diagram of another configuration of the transmitter 1. The configuration of the transmitter 1 shown in FIG. 8 is one in which the PLL

circuit 4 of the transmitter 1 shown in FIG. 2 is replaced by an OFDM demodulation circuit 41. The OFDM demodulation circuit 41 receives as input an OFDM signal serving as the reference and demodulates the OFDM signal to generate the window signal and clock. The transmitter 1 performs OFDM modulation by using the generated window signal and clock. By generating a new window signal and clock based on the input OFDM signal, the above conditions 1 through 3 are satisfied. Further, the carrier interval of signals to be transmitted is controlled based on the generated window signal, so also the condition 4 is satisfied.

FIG. 9 is a block diagram of still another configuration of the transmitter 1. In the configuration of the transmitter 1 shown in FIG. 9, the window signal and clock generated by the PLL circuit 4 of the transmitter 1 shown in FIG. 2 are supplied from a not illustrated other device. The OFDM modulation circuit 2 performs the IFFT operation by using the supplied window signal. Further, the OFDM modulation device 2 is controlled by the supplied clock. Then, the clock for controlling the frequency conversion circuit 3 is generated from the supplied window signal by the PLL circuit 5. By setting the window signal and clock supplied so as to satisfy the conditions 1 through 3, the

conditions 1 through 3 are satisfied. Further, the carrier interval of signals transmitted is controlled based on the supplied window signal, so also the condition 4 is satisfied.

In this way, in the transmitting apparatus to which the present invention is applied, it becomes possible to transmit a signal enabling the desired signal to be detected free from the influence of an adjacent signal even if no guard band is provided, in other words, where the adjacent signals are orthogonal to each other.

In the present specification, the provision medium for providing the user with a computer program for executing the processing includes, other than information storage media such as a magnetic disc and a CD-ROM, the medium of transmission over a network such as the Internet or a digital satellite.

CAPABILITY OF UTILIZATION IN INDUSTRY

As described above, according to the transmitting apparatus disclosed in claim 1, the transmission method disclosed in claim 2, and the provision medium disclosed in claim 3, since the first clock and the second window signal are generated from the input first window signal, the OFDM signal is modulated in accordance with information by using the first clock and the second window signal, and the second clock for controlling the

transmission interval of OFDM signals so that the carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of the carriers adjacent to each other in the OFDM signal is generated from the second window signal, it becomes possible to obtain the desired signal free from the influence of an adjacent signal even if no guard band is provided.

According to the transmitting apparatus disclosed in claim 4, the transmission method disclosed in claim 5, and the provision medium disclosed in claim 6, since the window signal and the first clock are generated by demodulating the input OFDM signal, the OFDM signal is modulated in accordance with information by using the generated window signal and first clock, and the second clock for controlling the transmission interval of OFDM signals so that the carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of the carriers adjacent to each other in the OFDM signal is generated from the generated window signal, it becomes possible to obtain the desired signal free from the influence of an adjacent signal even if no guard band is provided.

According to the transmitting apparatus disclosed in claim 7, the transmission method disclosed in claim 8,

and the provision medium disclosed in claim 9, since the OFDM signal is modulated in accordance with information by using the input window signal and first clock and the second clock for controlling the transmission interval of OFDM signals so that the carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of the carriers adjacent to each other in the OFDM signal is generated from the input window signal, it becomes possible to obtain the desired signal free from the influence of an adjacent signal even if no guard band is provided.

CLAIMS

1. A transmitting apparatus for OFDM modulating and transmitting predetermined information, said transmitting apparatus characterized by including

an inputting means for inputting a first window signal serving as a reference,

a first generating means for generating a first clock and a second window signal from the first window signal input by the inputting means,

a modulating means for modulating an OFDM signal in accordance with the information by using the first clock and the second window signal, and

a second generating means for generating, from the second window signal, a second clock for controlling a transmission interval of OFDM signals so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

2. A transmission method for OFDM modulating and transmitting predetermined information, said transmission method characterized by including

an input step of inputting a first window signal serving as a reference,

a first generation step of generating a first clock and a second window signal from the first window

signal input at the input step,

a modulation step of modulating an OFDM signal in accordance with information by using the first clock and the second window signal, and

a second generation step of generating, from the second window signal, a second clock for controlling a transmission interval of OFDM signals so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

3. A provision medium characterized in that it provides, to a transmitting apparatus for OFDM modulating and transmitting predetermined information, a computer readable program for making it run processing including

an input step of inputting a first window signal serving as a reference,

a first generation step of generating a first clock and a second window signal from the first window signal input at the input step,

a modulation step of modulating an OFDM signal in accordance with information by using the first clock and the second window signal, and

a second generation step of generating, from the second window signal, a second clock for controlling a transmission interval of OFDM signals so that a carrier

interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

4. A transmitting apparatus for OFDM modulating and transmitting predetermined information, said transmitting apparatus characterized by including

an inputting means for inputting an OFDM signal serving as the reference,

a first generating means for generating a window signal and a first clock by demodulating the OFDM signal input by the inputting means,

a modulating means for modulating an OFDM signal in accordance with information by using the window signal and first clock generated by the first generating means, and

a second generating means for generating, from the window signal generated by the first generating means, a second clock for controlling a transmission interval of OFDM signals generated by the modulating means so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

5. A transmission method for OFDM modulating and transmitting predetermined information, said transmission

method characterized by including

an input step of inputting an OFDM signal serving as a reference,

a first generation step of generating a window signal and a first clock by demodulating the OFDM signal input at the input step,

a modulation step of modulating an OFDM signal in accordance with information by using the window signal and first clock generated at the first generation step, and

a second generation step of generating, from the window signal generated at the first generation step, a second clock for controlling a transmission interval of OFDM signals generated at the modulation step so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

6. A provision medium characterized in that it provides, to a transmitting apparatus for OFDM modulating and transmitting predetermined information, a computer readable program for making it run processing including

an input step of inputting an OFDM signal serving as a reference,

a first generation step of generating a window signal and a first clock by demodulating the OFDM signal

input at the input step,

a modulation step of modulating an OFDM signal in accordance with information by using the window signal and first clock generated at the first generation step, and

a second generation step of generating, from the window signal generated at the first generation step, a second clock for controlling a transmission interval of OFDM signals generated at the modulation step so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

7. A transmitting apparatus for OFDM modulating and transmitting predetermined information, said transmitting apparatus characterized by including

an inputting means for inputting a window signal and a first clock serving as a reference,

a modulating means for modulating an OFDM signal in accordance with information by using the window signal and first clock input by the inputting means, and

a generating means for generating, from the window signal input by the inputting means, a second clock for controlling a transmission interval of OFDM signals generated by the modulating means so that a carrier interval between one OFDM signal and an adjacent

OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

8. A transmission method for OFDM modulating and transmitting predetermined information, said transmission method characterized by including

an input step of inputting a window signal and first clock serving as a reference,

a modulation step of modulating an OFDM signal in accordance with information by using the window signal and first clock input at the input step, and

a generation step of generating, from the window signal input at the input step, a second clock for controlling a transmission interval of OFDM signals generated by the modulating means so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

9. A provision medium characterized in that it provides, to a transmitting apparatus for OFDM modulating and transmitting predetermined information, a computer readable program for making it run processing including

an input step of inputting a window signal and first clock serving as a reference,

a modulation step of modulating an OFDM signal in accordance with information by using the window signal

and first clock input at the input step, and

a generation step of generating, from the window signal input at the input step, a second clock for controlling a transmission interval of OFDM signals generated by the modulating means so that a carrier interval between one OFDM signal and an adjacent OFDM signal becomes a whole multiple of the interval of carriers adjacent to each other in the OFDM signal.

FIG.1

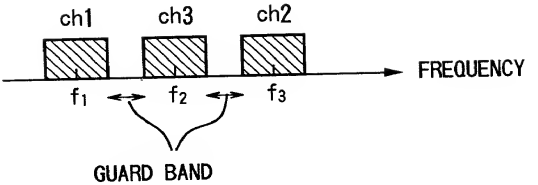


FIG.2

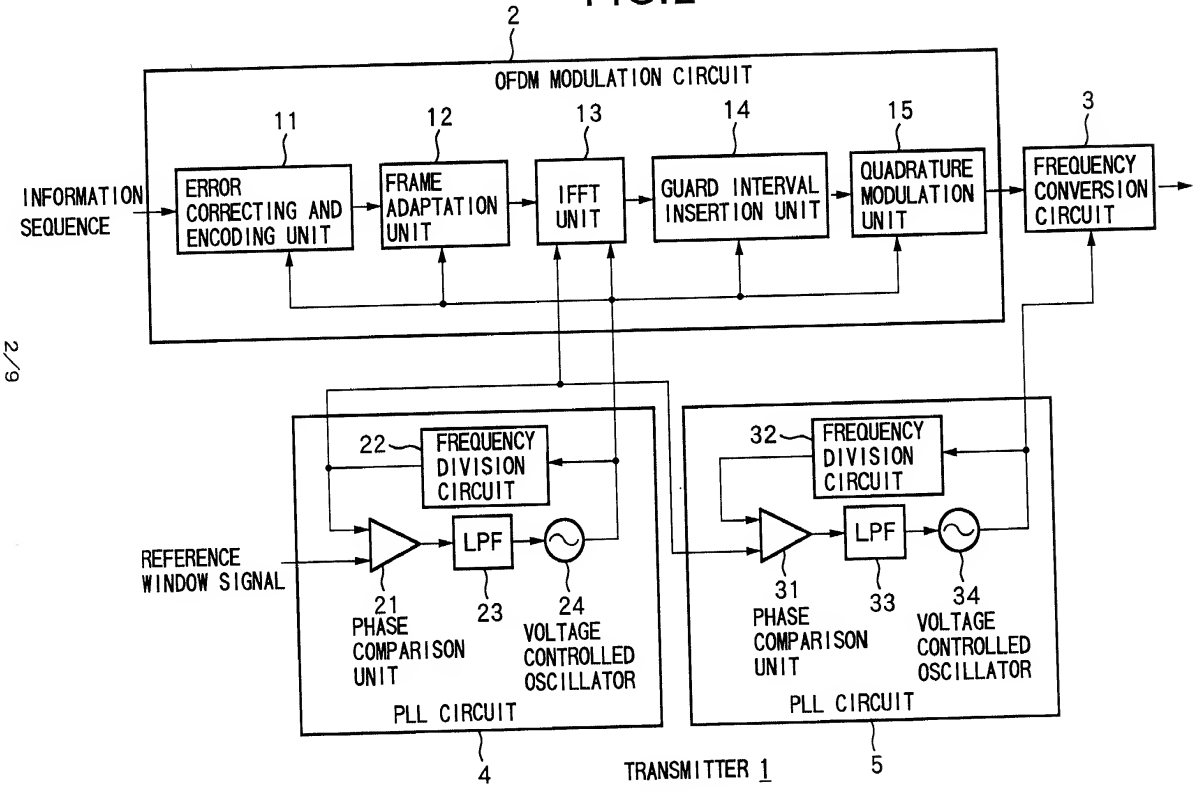


FIG.3

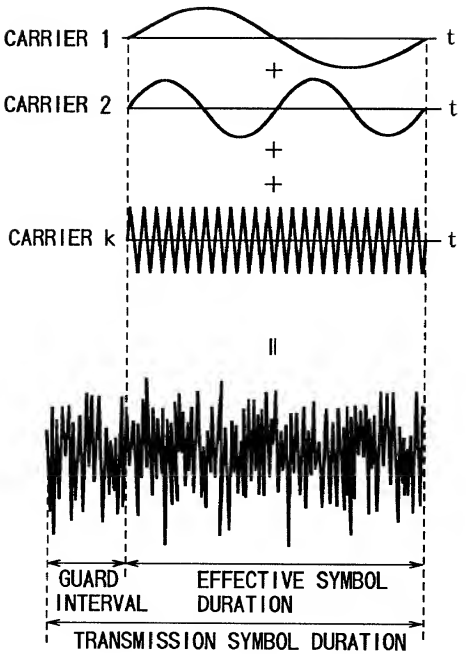

CARRIER 1
t
+
CARRIER 2
t
+
+
CARRIER k
t
=
GUARD INTERVAL
EFFECTIVE SYMBOL DURATION
TRANSMISSION SYMBOL DURATION

FIG.4A

FIG.4B

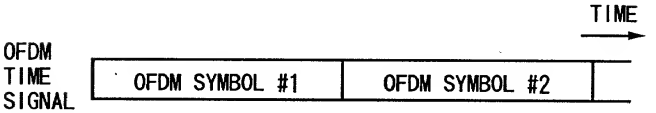


FIG.4C

FIG.4D

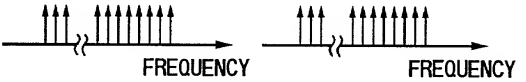


FIG.5A

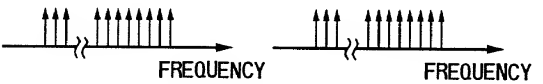


FIG.5B

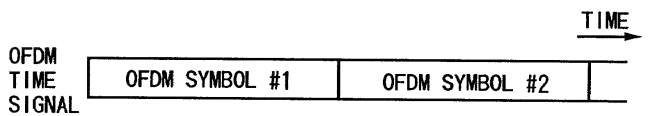


FIG.5C

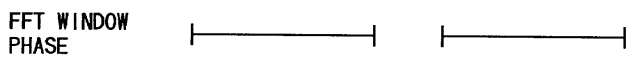


FIG.5D

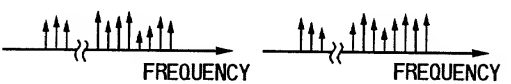


FIG.6A

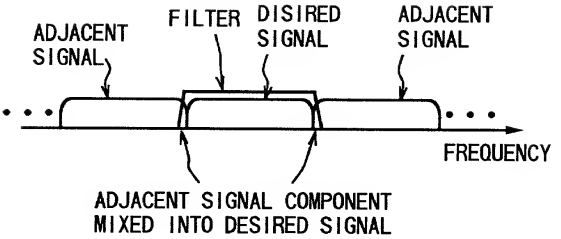

ADJACENT SIGNAL
FILTER
DISIRED SIGNAL
ADJACENT SIGNAL
FREQUENCY
ADJACENT SIGNAL COMPONENT MIXED INTO DESIRED SIGNAL

FIG.6B

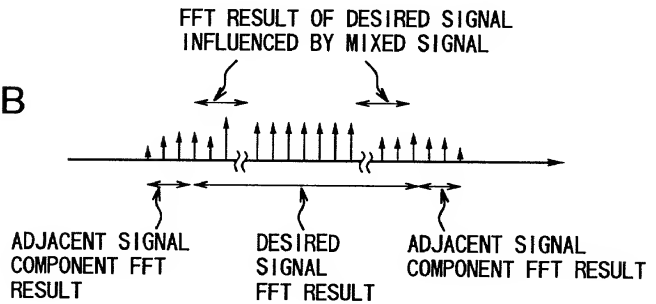
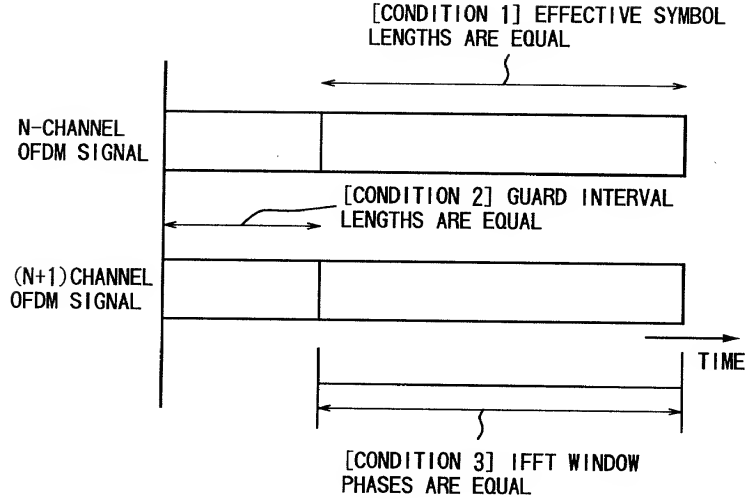
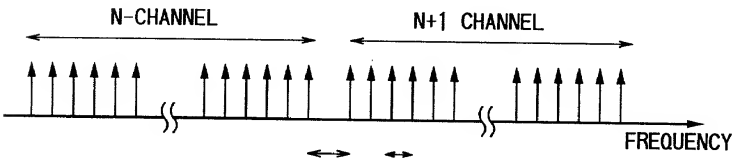

FFT RESULT OF DESIRED SIGNAL INFLUENCED BY MIXED SIGNAL
ADJACENT SIGNAL COMPONENT FFT RESULT
DESIRED SIGNAL FFT RESULT
ADJACENT SIGNAL COMPONENT FFT RESULT

FIG.7





[CONDITION 4] CARRIER INTERVAL BETWEEN CHANNELS IS WHOLE MULTIPLE OF CARRIER INTERVAL IN CHANNEL

FIG.8

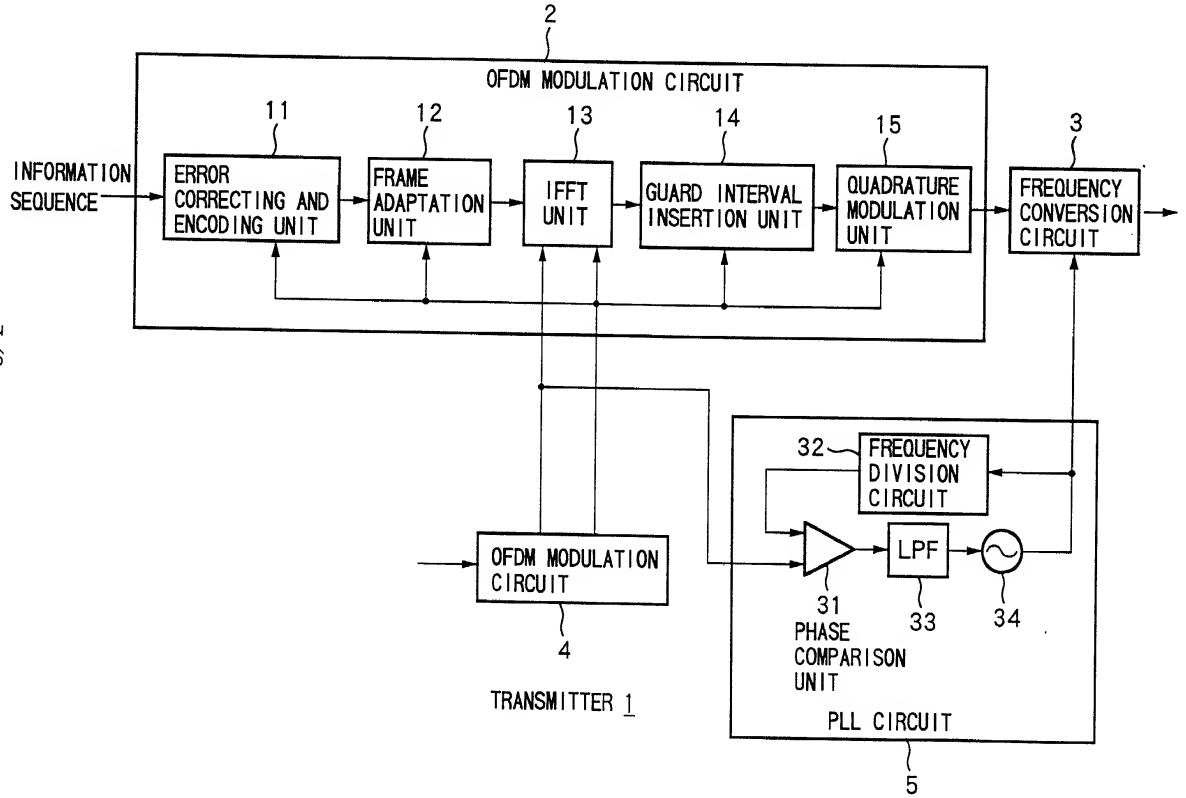
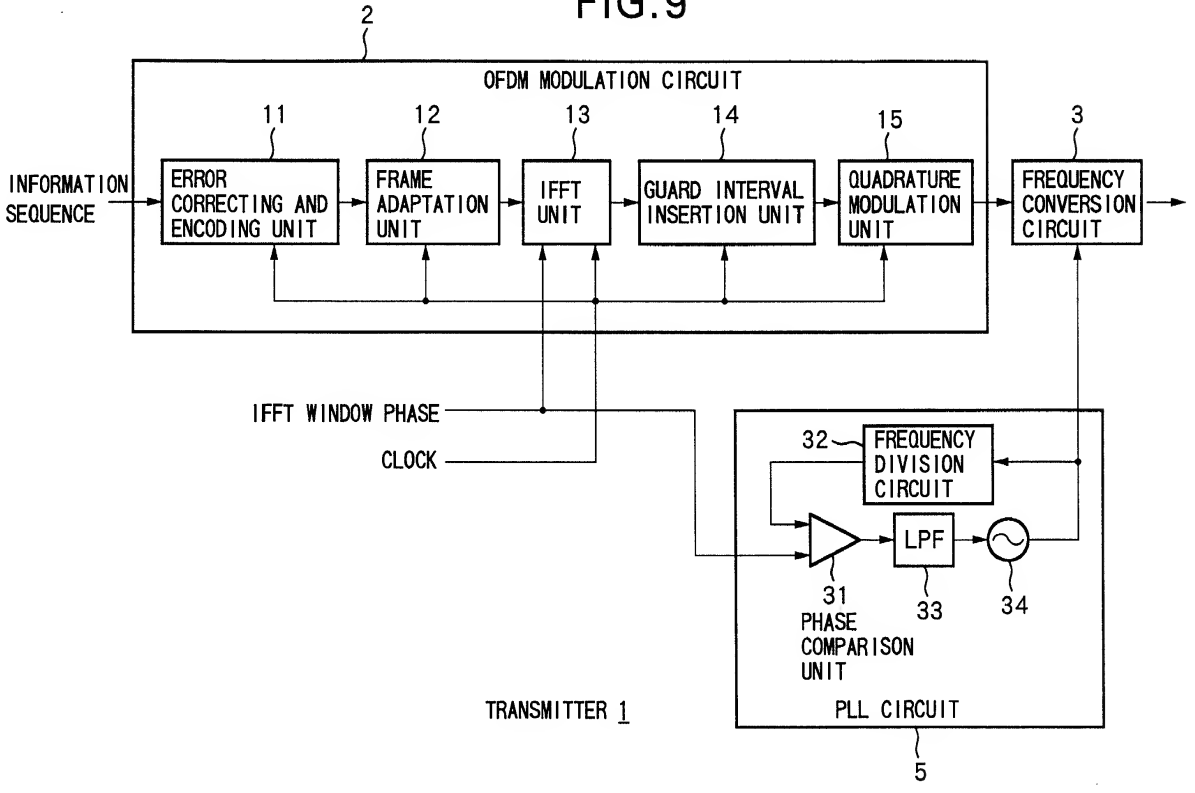

2
OFDM MODULATION CIRCUIT
11
12
13
14
15
3
INFORMATION SEQUENCE
ERROR CORRECTING AND ENCODING UNIT
FRAME ADAPTATION UNIT
IFFT UNIT
GUARD INTERVAL INSERTION UNIT
QUADRATURE MODULATION UNIT
FREQUENCY CONVERSION CIRCUIT
32
FREQUENCY DIVISION CIRCUIT
OFDM MODULATION CIRCUIT
LPF
31
PHASE COMPARISON UNIT
33
34
4
TRANSMITTER 1
PLL CIRCUIT
5

FIG.9



450118-02400
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Declaration and Power of Attorney for Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

私は、以下に記名された発明者として、ここに下記の通り宣言する：

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私の住所、郵便の宛先そして国籍は、私の氏名の後に記載された通りである。

My residence, post office address and citizenship are as stated next to my name:

☐ 下記の名称の発明について、特許請求範囲に記載され、且つ特許が求められている発明主題に関して、私は、最初、最先且つ唯一の発明者である（唯一の氏名が記載されている場合）か、或いは最初、最先且つ共同発明者である（複数の氏名が記載されている場合）と信じている。

I believe I am the original, first and sole inventor if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

TRANSMITTING APPARATUS AND METHOD AND PROVISION MEDIUM

上記発明の明細書はここに添付されているが、下記の箱がチェックされている場合は、この限りでない：

the specification of which is attached hereto unless the following box is checked:

☐ _____ の日に出願され、
この出願の米国出願番号またはＰＣＴ国際出願番号は、
_____ であり、且つ
_____ の日に補正された出願（該当する場合）

☒ was filed on March 10, 2000
as United States Application Number of
PCT International Application Number PCT/JP00/01483
_____ and was amended on
_____ (if applicable).

私は、上記の補正書によって補正された、特許請求範囲を含む上記明細書を検討し、且つ内容を理解していることをここに表明する。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第３７編規則１．５６に定義されている、特許性について重要な情報を開示する義務があることを認める。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

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00034892

日本語宣言書

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I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT international application having a filing date before that of the application for which priority is claimed.

Prior Foreign Application(s)

外国での先行出願

		Priority Not Claimed 優先権主張なし
11-066637 (Number) （番号）	Japan (Country) （国名）	12 March 1999 (Day/Month/Year Filed) ☐
PCT/JP00/01483 (Number) （番号）	PCT (Country) （国名）	10 March 2000 (Day/Month/Year Filed) ☐
(Number) （番号）	(Country) （国名）	(Day/Month/Year Filed) ☐
(Number) （番号）	(Country) （国名）	(Day/Month/Year Filed) ☐
(Number) （番号）	(Country) （国名）	(Day/Month/Year Filed) ☐
(Number) （番号）	(Country) （国名）	(Day/Month/Year Filed) ☐

私は、ここに、下記のいかなる米国仮特許出願についても、その米国法典第３５編１１９条(e)項の利益を主張する。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) （出願番号）	(Filing Date) （出願日）

私は、ここに、下記のいかなる米国出願についても、その米国法典第３５編第１２０条に基づく利益を主張し、又米国を指定するいかなるＰＣＴ国際出願についても、その同第３６５条(c)に基づく利益を主張する。また、本出願の各特許請求の範囲の主題が、米国法典第３５編第１１２条第１段に規定された態様で、先行する米国出願又はＰＣＴ国際出願に開示されていない場合においては、その先行出願の出願日と本国内出願日またはＰＣＴ国際出願日との間の期間中に入手された情報で、連邦規則法典第３７編規則１．５６に定義された特許性に関わる重要な情報について開示義務があることを承認する。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Application No.) （出願番号）	(Filing Date) （出願日）	(Status: Patented, Pending, Abandoned) （現況：特許許可、係属中、放棄）

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日本語宣言書

委任状： 私は本出願を審査する手続を行い、且つ米国特許商標庁との全ての業務を遂行するために、配名された発明者として、下記の弁護士及び／または弁理士を任命する。（氏名及び整理番号を記載すること）

2

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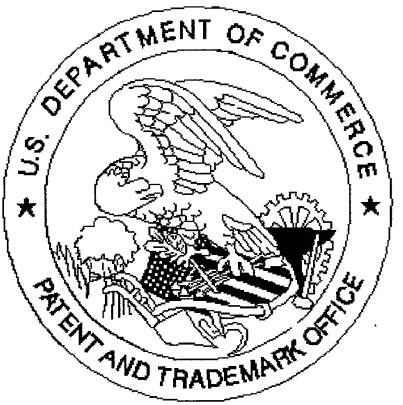

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